TITLE:	SAMPLING, ANALYSIS, AND PROPERTIES OF PRIMARY PM-2.5: APPLICATION TO COAL-FIRED UTILITY BOILERS
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ABSTRACT

OBJECTIVES

This project involves the design and construction of a state-of-the-art dilution sampler to investigate PM-2.5 (particulate matter with an aerodynamic diameter less than 2.5 μm) emissions from a pilot scale pulverized coal combustor. This sampler simulates the dilution and cooling processes that occur when the hot combustion products leave the stack. The goal is to provide a more basic understanding of the emissions of PM-2.5 from coal-based power generation systems.

ACCOMPLISHMENTS TO DATE

Work during the second year of the project has focused on the evaluation of the effects of dilution sampling on PM emissions from a pilot-scale coal combustor. The sampler was installed on a slipstream from the Combustion and Environmental Research Facility (CERF), a pilot scale pulverized coal combustor at the National Energy Technology Laboratory (NETL). For these experiments the CERF was operated on an Eastern Kentucky coal under stable conditions to provide a steady PM source.

Experiments were performed to investigate the effect of dilution sampling on the particle size distribution. For these experiments the particle number size distribution between 3 nm and 10 μm was measured as a function of dilution ratio and residence time. These measurements show a multimodal aerosol size distribution with a peaks at approximately 10 nm, 100 nm, and > 2.5 microns. The presence of the 10 nm peak is very sensitive to sampling conditions, and rapidly disappears with increasing

residence time due to coagulation. The results from the experiments and theoretical analysis show that coagulation is the process that primarily effects the particle size distributions.

Experiments were performed to examine the effect of dilution sampling on PM-2.5 mass emission rates and PM-2.5 composition. For these experiments filter samples were taken over a range of dilution ratios and residence time. The filter samples are currently being analyzed for water-soluble ions, metals, and organic and elemental carbon. Additional analysis are being performed using a scanning electron microscope to characterize the emissions on a single particle basis and to determine emission rates of spherical aluminosilicate particles which are used as a tracer primary PM emissions from coal-fired boilers. We expect to present the results from the analysis of the filter sample at the UCR program review meeting in June.

Significant modifications and improvements were made to the dilution sampling system during the second year of the project. Based the results from residence time experiments, the configuration of the residence time tank was changed to eliminate a fast path problem. The new configuration allows the addition of ports that enable simultaneously collecting samples at different residence times. This change dramatically increases our ability to investigate the effects of sampling on the PM-2.5 measurements.

SIGNIFICANCE TO FOSSIL ENERGY PROGRAMS

In July 1997, the EPA issued new particulate matter standards that targeted the mass of particles smaller than 2.5 micrometers (PM-2.5). Emissions from coal-fired power plants and other combustion sources are significant contributors to ambient PM-2.5. Coal-fired power plants emit little primary PM, but are the dominant source of SO_2 and a major source of NO_x -- both important precursors of secondary fine particulate matter. EPA estimated annual identifiable control costs corresponding to the partial attainment of the selected PM standard to be $8.6 billion per year, based on the analysis of five major emitting sectors, one of which is coal-based power plants. Design of cost-effective PM control strategies is limited by the lack of understanding of the difficulty of establishing the PM source-receptor relationships. This project aims to improve our basic knowledge of PM-2.5 emissions from coal-based power systems. This information will allow us to better identify the contribution of coal-boilers to ambient PM.

PLANS FOR THE COMING YEAR

During the final year of the project the dilution sampler will continue to characterize the primary PM-2.5 emissions from the Combustion and Environmental Research Facility. Experiments will focus on the effects of operating conditions and coal quality on emission rates and fingerprints. The following characterizations will be performed particle number size distribution between 3 nm and 10 μm, PM-2.5 mass, and basic PM-2.5 speciation (water soluble ions, metals, OC/EC), SEM analysis for spherical aluminosilicate particles as a function of sampling conditions. Exploratory experiments utilizing the Carnegie Mellon Smog chamber will be performed to examine the hygroscopic properties of the primary emissions and to look at secondary aerosol formation. Paper writing will be important component of the activities during the final year of the project. A journal paper is currently in preparation regarding the effects dilution sampling on PM from coal boilers.